232
8/12/86 JS (1)

40 I-27477 DR-1869-4

United States
Environmental Protection
Agency

Environmental Monitoring
Systems Laboratory
P.O. Box 15027
Las Vegas NV 89114-5027

EPA 600/4-86-030
DOE/DP/00539-057
July 1986

Research and Development

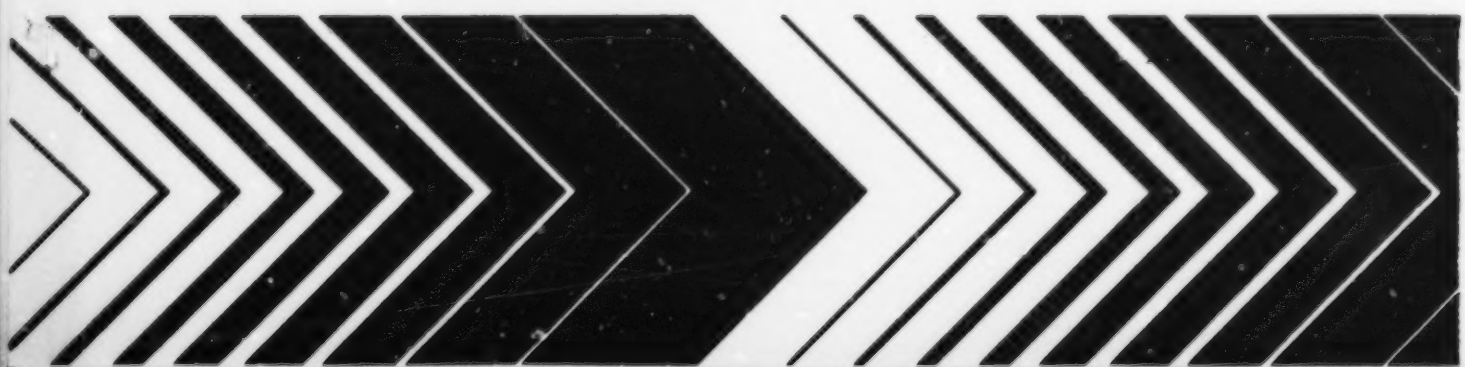
EPA

Off-Site Monitoring for the Mighty Oak Nuclear Test

prepared for the
U.S. Department of Energy
under Interagency Agreement
Number DE-A108-76DP00539

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED



DOE/DP/00539--057

DE86 014090

EPA/600/4-86-030
DOE/DP/00539-057
July 1986

OFF-SITE MONITORING FOR THE MIGHTY OAK NUCLEAR TEST

by

Stuart C. Black, Allan E. Smith and Charles F. Costa
Nuclear Radiation Assessment Division
U.S Environmental Protection Agency
Las Vegas, Nevada 89114

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

prepared for the
U.S. Department of Energy
under Interagency Agreement
Number DE-A108-76DP00539

ENVIRONMENTAL MONITORING SYSTEMS LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
LAS VEGAS, NEVADA 89114

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

LIST OF ABBREVIATIONS AND SYMBOLS

ABBREVIATIONS

ICRP	-- International Commission on Radiological Protection
I-131	-- radioactive iodine isotope, a radionuclide
MDC	-- Minimum Detectable Concentration
µrem	-- microrem = one millionth of a rem
mrem	-- millirem = one thousandth of a rem
m^3	-- cubic meter, about 35 cubic feet
pCi	-- picocurie - unit representing 2.22 atoms decaying per minute
rem	-- unit of dose = 100 ergs per gram x modifying factors
Xe-133	-- radioactive xenon isotope, a radionuclide

INTRODUCTION

The Mighty Oak event was a low-yield (less than 20 kt) test conducted in the T-tunnel on the Nevada Test Site (NTS) on April 10, 1986. As with all nuclear explosives tests conducted on the NTS, the Nuclear Radiation Assessment Division deployed personnel and equipment in the area downwind from the test location to measure any radioactivity which might be released as a result of the test. The normal monitoring networks for detecting airborne or other radioactivity were also operating. These networks and the operating procedures are described in annual reports entitled "Off-Site Environmental Monitoring Report," the latest issue of which has the report number EPA-600/4-85-035.

During and immediately following the detonation of Mighty Oak, no radioactivity related to that test was detected by the off-site radiation safety personnel or by the monitoring networks. Following the Mighty Oak event the DOE Test Controller notified the Nuclear Radiation Assessment Division (NRD) that a ventilation procedure would be instituted within the next several days to purge the tunnel of airborne radioactive materials so that personnel could re-enter the tunnel to recover equipment and records. Ventilation or purging of a tunnel involves the extraction of tunnel air with clean air make-up, filtration of the extracted air through particulate and charcoal filters, and further dilution with clean make-up air prior to environmental release. As a result of

this procedure, most of the radioactive noble gases in the tunnel air and a very small fraction of other radionuclides are discharged into the atmosphere.

To more readily follow the steps in the purging procedures described below, a schematic drawing of the outer portions of the tunnel is shown in Figure 1.

PROCEDURES

Purging of the tunnel, when the amount of radioactivity contained therein is high enough that it may be detectable off site, is performed only when the wind will carry the radioactivity into unpopulated or sparsely populated areas so that exposures will be as low as reasonably achievable. To insure this, purging is performed only when meteorological data from the Weather Service indicates an acceptable wind direction and speed. NRD is then notified of the planned purging schedule so that special noble gas samplers and air samplers equipped with particulate and charcoal filters can be placed in appropriate locations to supplement the routine monitoring networks.

After the purging and requisite sampling period the noble gas and air filter samples are collected and returned to the laboratory for analysis. The noble gas and air samplers are re-started in place or moved to new locations as necessary. The noble gas samples are analyzed for xenon-133 and krypton-85 and the air filters are analyzed for gamma-emitting radionuclides (e.g. iodine-131) by means of gamma spectrometry.

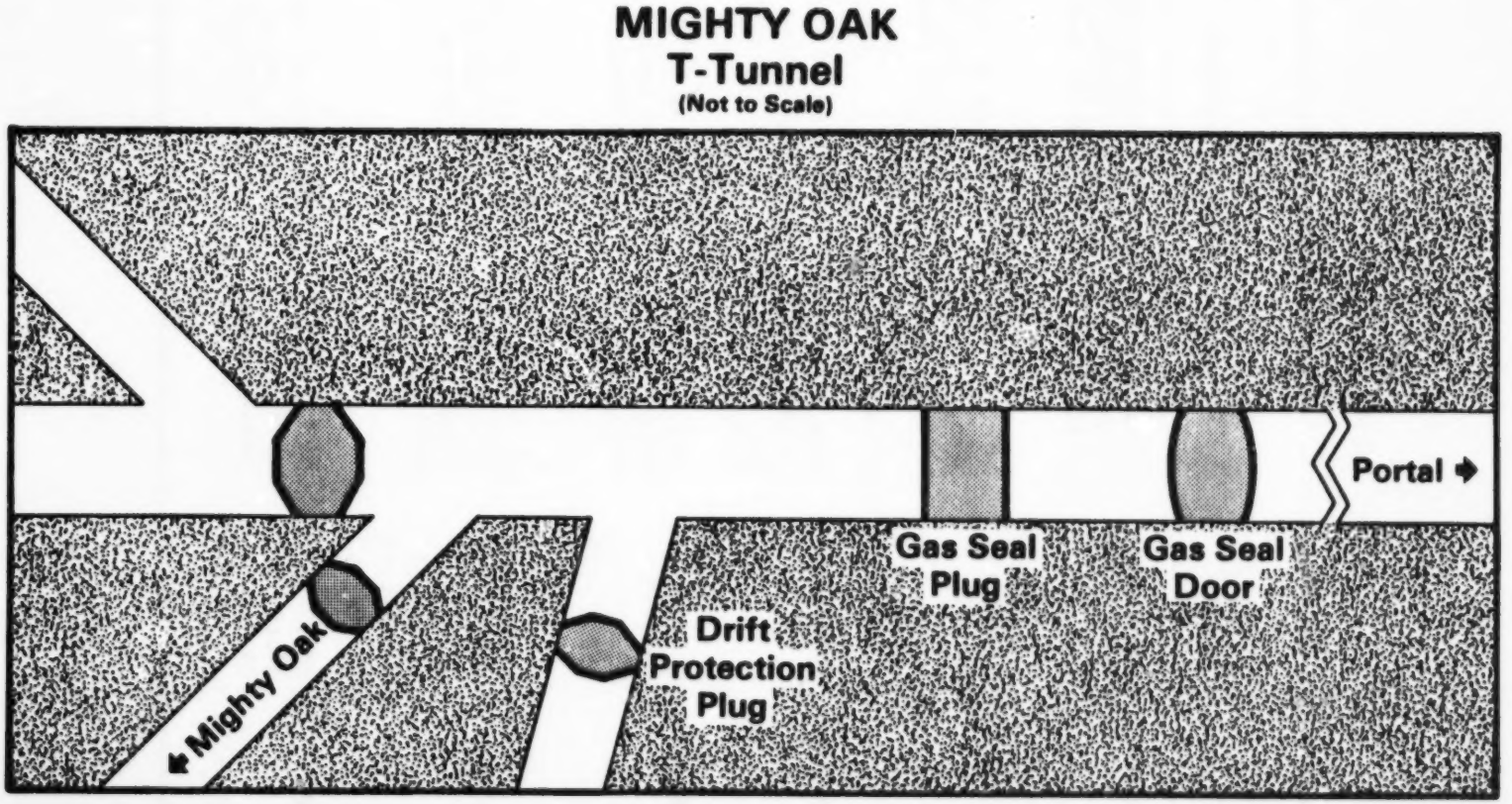


Figure 1. Schematic diagram of a test tunnel.

TABLE 1. PURGING AND MONITORING SCHEDULE

Date 1986	Wind Sector	Purging Times - PST	Sampler Locations	Comments
04/16	Hiko-Rachel	1445-1500	Medlin Rn., Rachel, Hiko, Alamo	Relieved excess pressure between Gas Plug and Drift Protection Plug.
04/22	Reed-Rachel	1000 4/22 to 1030 4/23	Twin Springs Rn., Hiko, Medlin Rn., Reed Rn. turn-off, Pioche, Penoyer Farm	Purging of tunnel between the Gas Plug and Drift Protection Plug.
04/25	Rachel-Alamo	1030-1400	Hiko, Glendale, Penoyer Farm, Twin Springs Rn., Medlin Rn.	Purging of the tunnel behind the Drift Protection Plug.
04/28 to 04/30	Rachel-Alamo	1000 4/28 to 0300 4/29 1030 to 1500 4/29	Hiko, Penoyer Farm, Medlin Rn.	Purging of the tunnel behind the Drift Protection Plug.
04/30 to 05/5	Hiko to Warm Springs	1400 to 1800 4/30 1000 to 1930 5/1 0930 5/2 to 0520 5/4	Hiko, Twin Springs Rn., Penoyer Farm, Medlin Rn.	Purging of the tunnel behind the Drift Protection Plug.
05/5 to 05/09	variable	continuous after 1540 on 5/4	Hiko, Twin Springs Rn., Penoyer Farm	Purging of the tunnel behind the Drift Protection Plug.

The purging times and sampler locations are shown in Table 1 for the period from April 16, the initiation of the purging, until May 9. Special sampling was discontinued after May 9 following return of airborne xenon concentrations to background levels. Location of the special samplers and centerline wind directions during purging are shown in Figure 2.

RESULTS

The results from the analyses of the special samples collected during the purging are shown in Tables 2 and 3. Also operating during this time were the routine Air Surveillance Network (ASN - 30 locations, Figure 3), the Noble Gas and Tritium Surveillance Network (NGTSN - 15 locations, Figure 4), the Pressurized Ion Chamber Network (PIC - 23 locations), and thermoluminescent dosimeters at 127 locations. The PIC's are at all the NGTSN stations shown in Figure 4 plus Complex 1, Furnace Creek, Lathrop Wells, Nyala, Stone Cabin Ranch, Tikaboo Valley and Twin Springs Ranch. These routine networks operate continuously year round. Other than background levels of krypton-85, the only radioactivity detected by these networks were xenon-133 concentrations of 36 and 38 pCi/m^3 at Rachel and Alamo, respectively, in 1 week samples collected April 23 through April 30. Of all the samples collected the week ending May 9, only that collected at Rachel (operated 4/30 to 5/7) had a detectable xenon concentration (Table 2). This was most likely due to the purging from May 1 to May 4 since no xenon was detected in the sample collected at Penoyer Farm, which is closer to the NTS, during the period May 5 to May 9.

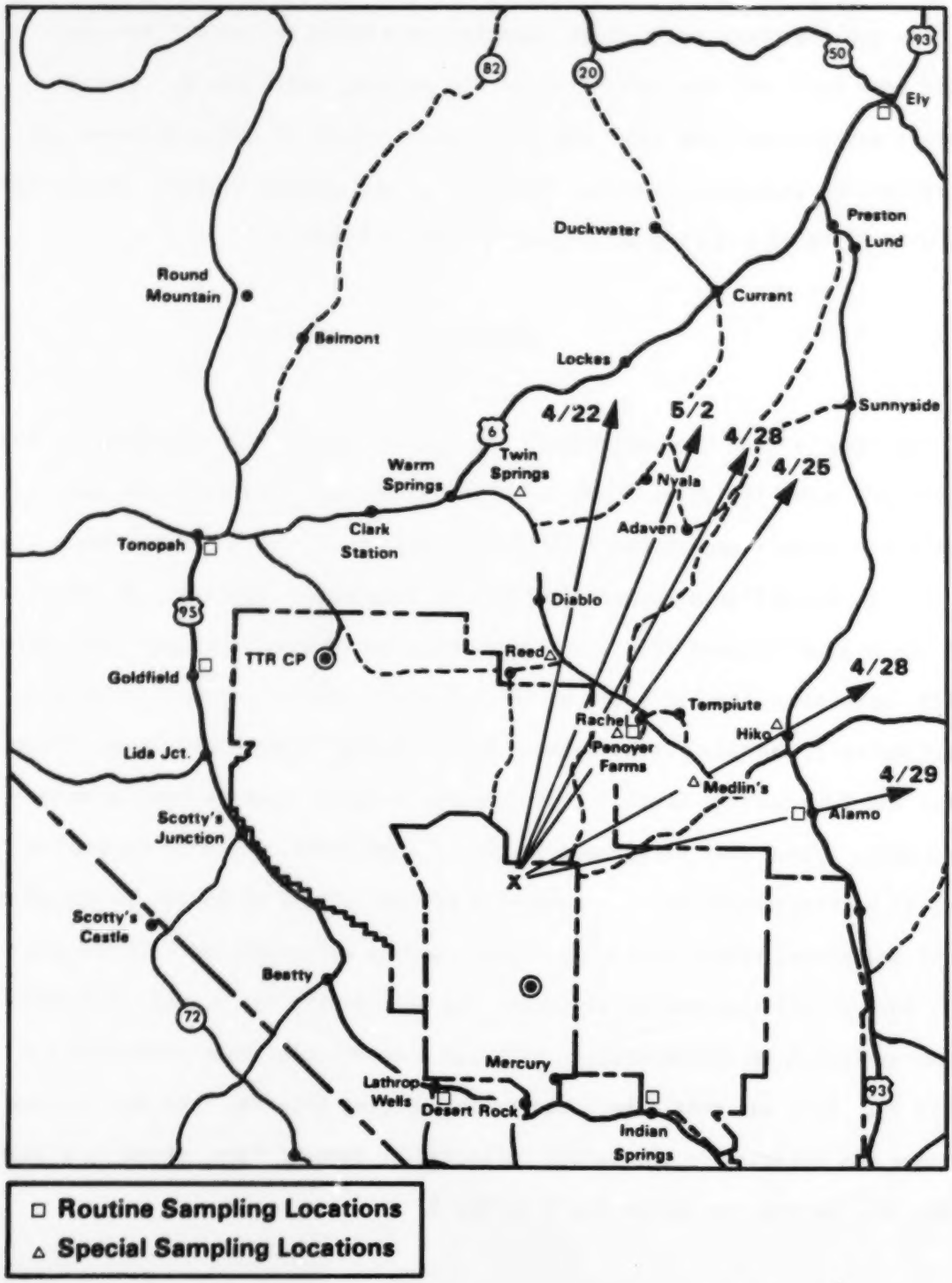


Figure 2. Special sampler locations and centerline winds.

TABLE 2. XENON-133 SPECIAL STUDY-MIGHTY OAK

Location	Start Day	Start Time Hour	Run Time Hours	Result pCi/m^3
Alamo, NV	04/09*	1030	169	ND
	04/16	1140	23	ND
	04/16*	1150	167	ND
	04/23*	1230	168	38 ± 7
	04/30*	1145	169	ND
Reed Rn. Turnoff	04/22	1030	23	81 ± 10
Glendale, NV	04/25	1200	25	ND
Hiko, NV	04/16	1100	23	ND
	04/21	1300	48	ND
	04/25	1100	23	270 ± 7
	04/28	1030	48	116 ± 20
	04/30	1100	120	ND
	05/05	1130	95	ND
Pioche, NV	04/22	1100	96	ND
Rachel, NV	04/09*	0930	168	ND
	04/16	1040	22	ND
	04/16*	1015	168	ND
	04/23*	1200	166	36 ± 7
	04/30*	1000	169	26 ± 8
Penoyer Farm	04/22	1200	22	23 ± 6
	04/25	1000	17	ND
	04/28	1115	49	210 ± 7
	04/30	1245	121	35 ± 7
	05/05	1400	92	ND
Medlin Rn. (Tikaboo Valley)	04/16	1130	22	ND
	04/22	0800	28	ND
	04/25	1300	11	550 ± 15
	04/28	1235	47	120 ± 6
	04/30	1130	120	ND
Twin Springs Rn.	04/21	1020	48	ND
	04/25	1000	26	insufficient
	04/30	1430	120	124 ± 8
	05/05	1500	92	ND

*NGTSN samples

TABLE 3. SPECIAL AIR FILTER SAMPLES - pCi/m^3

Location	Date Off								
	4/17	4/23	4/26	4/30	5/5	5/7	5/8	5/5-5/9	5/10
Alamo	GSN*	GSN	GSN	GSN				I-131-0.5	I-131-1.2
Glendale			GSN						
Hiko	GSN	GSN**	GSN	GSN	GSN			I-131-0.2	I-131-1.2
Lathrop Wells	GSN	GSN	GSN	GSN	GSN	GSN	I-131-0.10	I-131-0.9	I-131-1.9
Medlin Rn.	GSN	GSN**	GSN	GSN	GSN				
Penoyer Farm		GSN	GSN	GSN	GSN			I-131-0.20	
Pioche			GSN						
Rachel	GSN	GSN		GSN	GSN	GSN	GSN		I-131-1.5
Reed Rn Turnoff		GSN**							
Twin Springs		GSN**	GSN		GSN	GSN	GSN	I-131-0.1	I-131-4.6

*GSN - gamma spectrum negligible

** - beryllium-7 detected, a natural radionuclide

NOTE: First detectable Chernobyl fallout found 5/7 in air samples from Denver CO, Elko NV, Delta, Milford and Bryce Canyon UT, and in snow from Mt. Charleston.

Figure 3. Air Surveillance Network stations (1985).

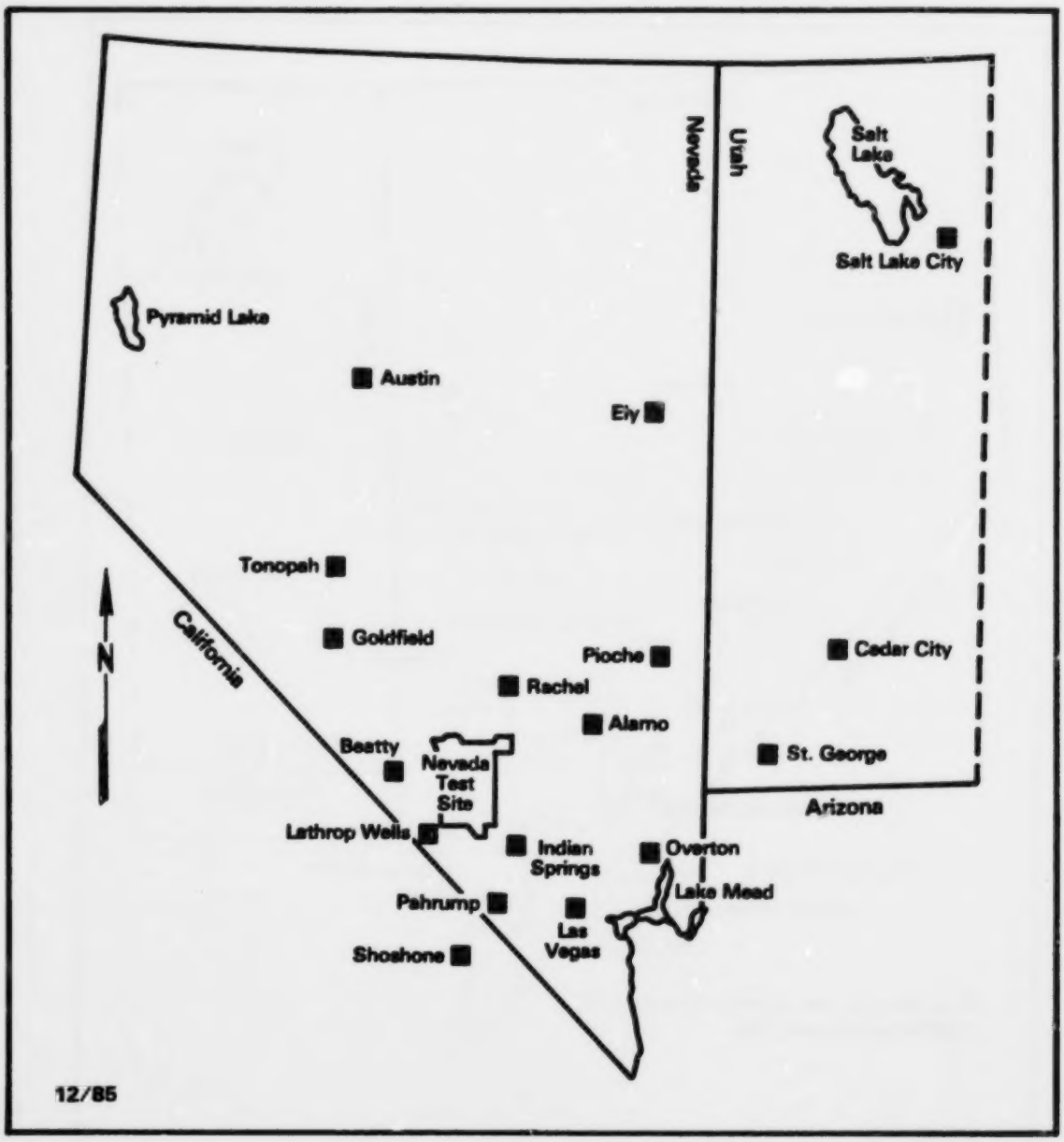


Figure 4. Noble Gas and Tritium Surveillance Network sampling locations.

SUMMARY AND CONCLUSIONS

During the purging procedure following the Mighty Oak event, special sampling for radioactive noble gases and other airborne radioactivity was performed. The location of the special samplers and their operating times were determined from information supplied by the U.S. Weather Service and the Nevada Operations Office, U.S. Department of Energy.

For the sampling periods indicated in Table 1, 33 samples were collected and analyzed; 12 indicated the presence of low concentrations of xenon-133. The maximum detected was 550 pCi/m^3 for a sampling period of 11 hours at Medlin's Ranch. This should be compared to the continuous exposure of 480,000 pCi/m^3 which would be required to reach the annual whole-body dose limit of 100 mrem to a person in the general population as recommended by the ICRP. No gamma-emitting radionuclides were detected on any air filter samples during the period of the purging. The radionuclides shown in Table 3 starting May 8 originated from the reactor accident in the USSR (I-131 = iodine-131). Ruthenium-103 was also detected in some of these early samples.

To estimate the whole-body dose from exposure to the measured xenon concentrations listed in Table 2, the air concentration (pCi/m^3) is multiplied by the collection time and summed for each site. This sum is then multiplied by a dose conversion factor of 2.4×10^{-5} $\mu rem/(pCi\text{-}hr/m^3)$ to yield a whole body dose for that location. The dose conversion factor is determined by dividing the annual whole body dose limit (in μrem) by the product of 480,000 pCi/m^3 (the Derived Concentration Guide calculated using the International Commission

of Radiological Protection Report No. 30) and the number of hours per year (8,766). This whole body dose is then compared to the ICRP whole body dose limit of 100 mrem/yr (100,000 μrem/year) shown as %ICRP. These results are shown below. As an additional comparison, the whole body dose at each location is divided by the background dose rate to determine the extra minutes of equivalent background (min. bkg.) exposure.

Site	Sum ($pCi\text{-}hr/m^3$)	Dose-μrem	% ICRP	min. bkg.
Alamo	6,350	0.15	1.5×10^{-4}	0.7
Hiko	11,780	0.28	2.8×10^{-4}	1.5
Medlin	11,640	0.28	2.8×10^{-4}	1.0
Penoyer Farm	15,030	0.36	3.6×10^{-4}	1.3
Rachel	10,370	0.25	2.5×10^{-4}	0.9
Twin Springs	13,920	0.33	3.3×10^{-4}	1.2

The $pCi\text{-}hr/m^3$ normalized to a daily integrated concentration, averaged for the special samples, is plotted in Figure 5. Also shown are the start of each purge period, the equivalent concentrations from the network shown in Figure 3, and the minimum detectable concentration (MDC) during actual analysis. The plotted values are the results from analysis even though they might be less than the MDC. The detectable concentrations at Alamo and Rachel pushed the network average above the MDC for the period April 23 to April 30. The increase in off-site concentration of xenon-133 from the purging reached a maximum on April 25 and decreased to less than MDC after May 5.

In conclusion, the special monitoring for the tunnel purging following the Mighty Oak test indicated that only xenon-133 was detectable in off-site areas. No radioactivity attributable to Mighty Oak was detectable after May 5, 1986.

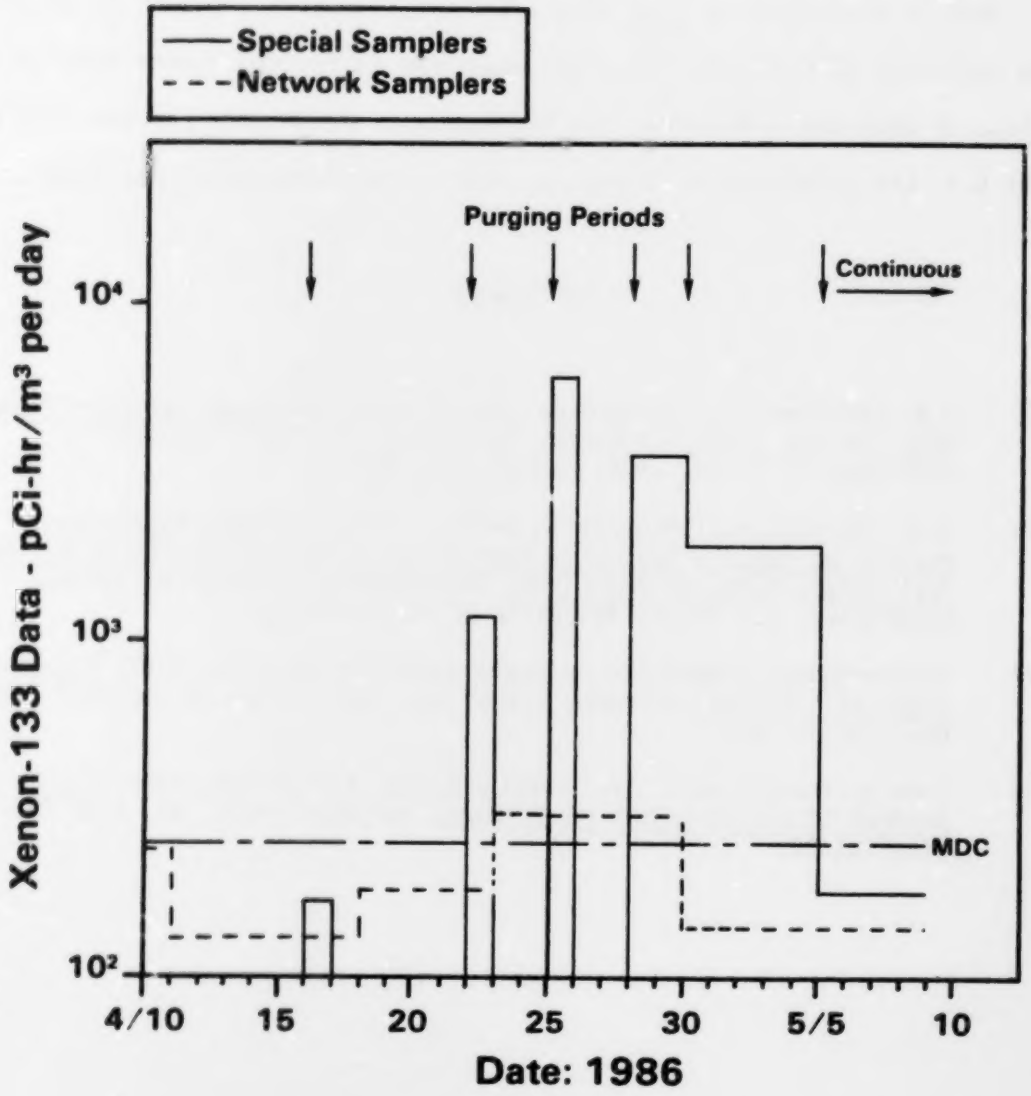


Figure 5. Integrated concentrations of xenon in Special and Routine Network noble gas samples.

The maximum radiation dose to an off-site resident, assuming that person remained outdoors during the total sampling period, would have been 0.36 μrem at Penoyer Farm. This is equivalent to less than 1-1/2 minutes extra exposure to the background radiation at that location. All exposures to residents were negligible fractions of both the ICRP guidelines for exposure of 100 mrem per year (ICRP77) and the U.S. EPA guideline of 25 mrem/yr from airborne radionuclides (EPA85a).

REFERENCES

EPA85a U.S. Environmental Protection Agency, 1985, National Emission Standards for Department of Energy Facilities, 40 CFR 61 Subpart H, published in FR:50, 5194, February 6, 1985.

EPA85b U.S. Environmental Protection Agency, 1985, Off-Site Environmental Monitoring Report: Radiation Monitoring Around United States Nuclear Test Areas, Calendar Year 1984, Environmental Monitoring Systems Laboratory, Las Vegas, NV Report EPA/600/4-85-035.

ICRP77 International Commission on Radiological Protection, 1977, Recommendations of the ICRP, Pergamon Press, NY, Publication 26 (Revised 1983, Publication 39).

ICRP79 International Commission on Radiological Protection, 1979, Limits for Intakes of Radionuclides by Workers, Pergamon Press, NY, ICRP Publication 30.

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. DOE DP00539-057	2.
3. RECIPIENT'S ACCESSION NO.	
4. TITLE AND SUBTITLE Off-Site Monitoring for the Mighty Oak Nuclear Test	5. REPORT DATE June 1986
	6. PERFORMING ORGANIZATION CODE EPA 600/07
7. AUTHOR(S) S. C. Black, A. E. Smith and C. F. Costa	8. PERFORMING ORGANIZATION REPORT NO. EPA 600/4-86-030 July 1986
9. PERFORMING ORGANIZATION NAME AND ADDRESS Nuclear Radiation Assessment Division Environmental Monitoring Systems Laboratory U. S. Environmental Protection Agency Las Vegas, Nevada 89114	10. PROGRAM ELEMENT NO. X6EH10
	11. CONTRACT/GRANT NO. IAG DE-AI08-76DP00539
12. SPONSORING AGENCY NAME AND ADDRESS Nevada Operations Office U.S. Department of Energy P. O. Box 14100 Las Vegas, NV 89114	13. TYPE OF REPORT AND PERIOD COVERED Response, Apr-May 86
	14. SPONSORING AGENCY CODE
15. SUPPLEMENTARY NOTES	

16. ABSTRACT

After a nuclear explosives test, code name Mighty Oak, the tunnel leading to the test point became contaminated with radioactive debris. To re-enter and recover valuable equipment and data, the DOE purged the tunnel air using particulate and charcoal filters to minimize discharge of radioactivity to the atmosphere. During this purging, the EPA established special air samples supplementing their routine air monitoring networks. Analysis of the collected samples for radioactive noble gases and for gamma-emitting radionuclides indicated that only low levels of xenon-133 were released in amounts detectable in populated areas near the Nevada Test Site. The maximum dose to an individual was calculated to be 0.36 microrem, assuming that person remained in the open field at the measurement site during the whole period of the purging.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

18. DISTRIBUTION STATEMENT RELEASE TO THE PUBLIC	19. SECURITY CLASS *(This Report)* UNCLASSIFIED	21. NO. OF PAGES 16
	20. SECURITY CLASS *(This page)* UNCLASSIFIED	22. PRICE

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE